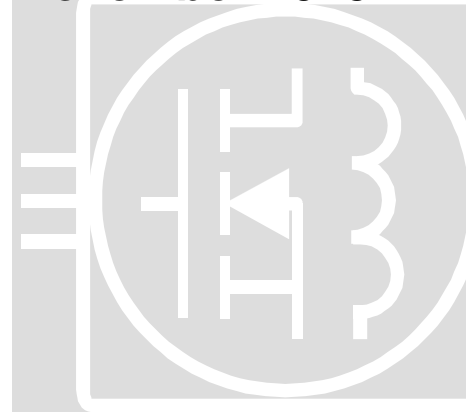


**Hardware Manual**

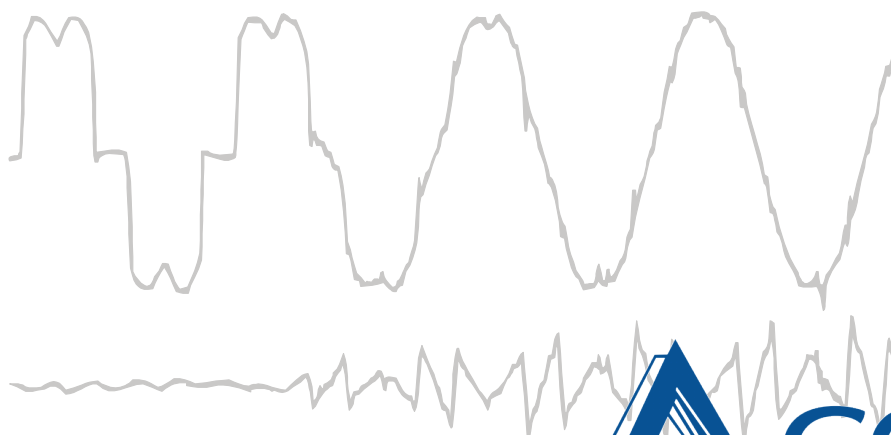
**November 2015**



**ADF**



# **ADF P100/P100N Hardware Manual**



**COMSYS**

Creating Value through Power Quality™

## Safety notes

Read these instructions carefully and look at the equipment to become familiar with the product before trying to install, operate or maintain it. The following special messages may appear throughout this manual to warn of potential hazards or to call attention to that which clarifies or simplifies a procedure:



**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or loss of life, property damage, or economic loss.

## NOTE

Provides additional information to clarify or simplify a procedure.



**ATTENTION:** Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

**ATTENTION:** The product contains DC bus capacitors which retain hazardous voltages in excess of 1000 V after input power has been disconnected. After disconnecting input power, wait at least sixty (60) minutes for the DC bus capacitors to discharge and then check the voltage with a voltmeter to ensure the DC bus capacitors are discharged before touching any internal components. Failure to observe this precaution could result in severe bodily injury or loss of life.

**ATTENTION:** This product may have been modified from factory in order for the auxiliary power to be supplied externally. After disconnecting main fuses, the external auxiliary power must also be disconnected.

**ATTENTION:** Before manipulating current transformers, make sure that the secondary is short-circuited. Never open the secondary of a loaded current transformer. You must always wear isolating gloves and eye-protection when working on electrical installations. Also make sure that all local safety regulations are fulfilled.

**ATTENTION:** Only qualified personnel or other trained personnel who understand the potential hazards involved may make service, updates, troubleshooting, repair or similar work to the product. Any such activities not made correctly may result in uncontrolled operation. Failure to observe this precaution could result in damage to equipment and bodily injury. Although reasonable care has been taken to provide accurate and authoritative information in this document, no responsibility is assumed by **Comsys** for any consequences arising out of the use of this material.

The information in this document is subject to change without notice.

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## Product identification

The product identification label is found at the front of the ADF. Remember to check that your supply is compatible with the technical data stated on the label before installing and commissioning the Active Filter.

### Active Filter ADF P100

**Technical data:**

Line voltage: 208 - 480 V  
 Frequency: 50/60 Hz  
 Current capacity: 130 A  
 Protection class: IP20  
 Cooling medium: Air  
 Ambient temperature: 0 - 40°C

**Product identification:**

Model: ADF P100-130/480  
 Art. No.: 400 098

**Serial number:**


**Comsys AB**  
[www.comsys.se](http://www.comsys.se)  
 Made in Sweden

This manual applies to products listed in the table below:

Table 1: Applicable ADF P100 models

Product line	Models	Current rating	Voltage	Art no
ADF P100 Air cooled, 3 wire	ADF P100-70/480	70 A <sub>RMS</sub>	208 – 480 V	400 096
	ADF P100-100/480	100 A <sub>RMS</sub>		400 097
	ADF P100-130/480	130 A <sub>RMS</sub>		400 098
	ADF P100-90/690	90 A <sub>RMS</sub>	480 – 690 V	400 082
ADF P100 Air cooled, 4 wire	ADF P100N-100/415	100 A <sub>RMS</sub> 300 A <sub>RMS</sub> $\Psi$	208 – 415 V	400 095

## Standards

This product is CE compliant, which implies that is in conformity with the European Community low voltage directives 72/23/EEC and 93/68/EEC and it bears the CE label.

The following standards apply:

Table 2: Standards

Standards	
Electromagnetic compatibility	EN 61000-6-2, EN 61000-6-4
Electrical design and safety	EN 50178 / VDE0160
Protection class	IP20 according to IEC 529
Approval marking	72/23/EEC, 93/68/EEC CE-mark

## Document revision

Table 3: Document revision

Revision	Date	History:	Status:
A	2013-01-21	INITIAL RELEASE HARDWARE PREVIEW	RELEASED
A1	2013-01-24	MINOR FIXES	RELEASED
B	2013-03-21	MINOR FIXES	RELEASED
C	2015-11-20	UPDATE FOR ADF P100N and 690 V	RELEASED

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# 1 Overview

## 1.1 Content

This manual describes the hardware, installation and maintenance topics of the Comsys ADF P100 series of active filters.

## 1.2 Organization of manual

The ADF P100 manual is organized in two parts, namely:

1. ADF P100/P100N Hardware Manual, doc no 1 199 273 (this document)
2. ADF P100/P300 User Manual, doc no 1 199 172 (version 1.8.0 or later)

The Hardware Manual covers hardware related issues, such as installation, cable selection, CT configuration, preventive maintenance, and troubleshooting.

The user manual covers issues which are governed by the installed software in the system such as operation, initial configuration and commissioning. Hence, when the system is updated, a new User Manual is supplied.

## 1.3 Related documentation

- ADF P100/P300 User Manual; doc no 1 199 172 (version 1.8.0 or later)

## 2 Active Filter Overview

### 2.1 Introduction to the Technology

COMSYS offers a new generation of high performance power quality products for industrial applications based on active filter technology, which removes the losses and restores the natural wave shape of the current.

#### 2.1.1 The Problem: Poor Power Quality

Transients, harmonics, voltage variations (including flicker) and unbalance puts the power grid, machines, motors and computer equipment under considerable stress resulting in disturbances, production stops, waste of energy and decreased lifetime. These terms, among others, constitute power quality.

A large part of the equipment connected to the power grid creates disturbances, voltage variations and undesired harmonics that pollute the grid. This pollution generates losses, disturbances, productions stops and reduces expected lifetime of cabling, transformers and machines as a cause of the excess load.

This leads to decreased capacity in the electrical network, less effective electrical power consumption and energy losses that transforms into both technical and economic costs.

#### 2.1.2 The Solution: Active Filters

Traditionally fixed, electro-mechanical and semiconductor controlled filters and/or compensators have been used to limit or minimize power quality problems in the network.

They operate mainly on a fixed or stepped basis using passive elements. All these solutions suffer from the same drawbacks – they add losses, are installation specific and have no ability to adapt to or follow dynamic load changes. Further, they are instable over time due to changes in the grid and/or load conditions.

The Active Dynamic Filter (ADF) eliminates loss creating behaviors such as harmonics, flicker, voltage variations, resonances and reactive energy using a highly dynamic, step less digitally controlled compensation and filtering approach. By continuously monitoring the network and injecting exactly the right amount of compensation current – at exactly the right time – the most efficient and accurate solution to any power quality problem can be achieved.

This approach enables the current waveform to be restored instantaneously, the current consumption to be lowered and changes in load or installation conditions to be fully compensated at all times.

#### 2.1.3 Common applications which can benefit from Active Filters

- Harmonic/reactive power suppression in 3-phase systems
- Industrial production machines (e.g. mills, presses)
- Variable speed drive systems (AC drives, DC drives)
- Electrical welding systems
- Plastic machinery (extruders, injection molders, film treatment machines)
- Power generation systems and UPS equipment
- Electrolytic processes
- Induction heating

#### 2.1.4 How Active Filters Work

An active filter is basically a very advanced computer controlled current generator with the ability to produce any shape or form of current with little or no delay.

A simplified diagram of the operating principle is shown in Figure 1. The system is connected in parallel with the load requiring compensation.

Currents and voltage delivered from the network are measured and analyzed [3], to determine if disturbances such as e.g. reactive displacement and/or harmonics are present.

The system injects compensation currents [2] which is the exact opposite of the e.g. harmonics and/or reactive displacement to cancel out the undesired behavior of the load [1].

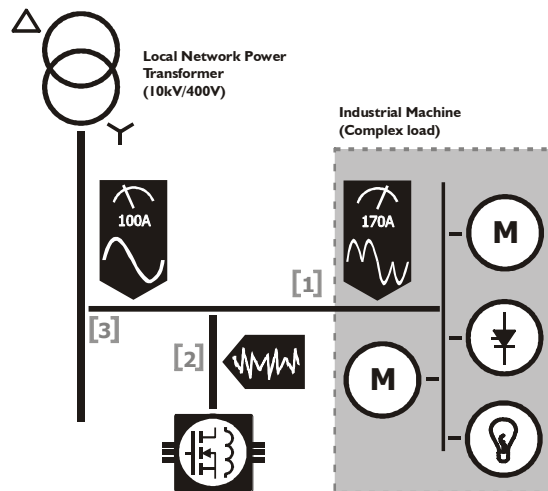


Figure 1: Basic operating principle

The Figure 2 shows how the current consumed by an electrical load may look like prior to and during compensation. Before compensation, the current consists of several harmonics in addition to the fundamental, which are apparent from the current's deformed waveform. After injection of the compensation current, the load current's natural sinusoidal waveform is restored and the loss creating behaviors have been eliminated.

The function of the power transmission system is restored, which leads to saved energy, lower disturbances or in short – improved power quality and significantly lowered costs in electrical installations.

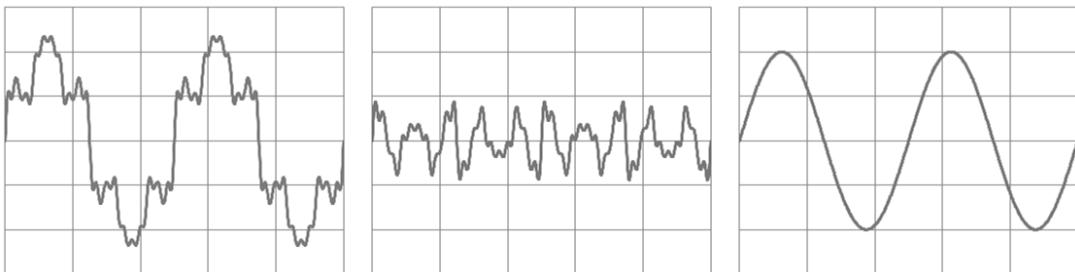


Figure 2: Uncompensated load current (left), Compensation current (middle), Compensated net current (right)

## 2.2 System Overview

The Active Filter ADF P100 is a stand-alone and modular high power active power filter. It can be mounted inside a machine as OEM, inside a cabinet in system integration and directly on the wall. Several ADF P100 units can work in parallel.

### 2.2.1 Features

General features:

- Compact design in ready-to-use wall mounted enclosure
- High performance and reliability
- Advanced digital control and low response time
- Several units can be operated in parallel for higher power ratings
- Suitable for embedded solutions
- Non-overloadable and insensitive to changes in network or load conditions
- Easy installation, commissioning and maintenance

## 2.2.2 Main components overview

This section describes the major components of the ADF P100 Active Filter.

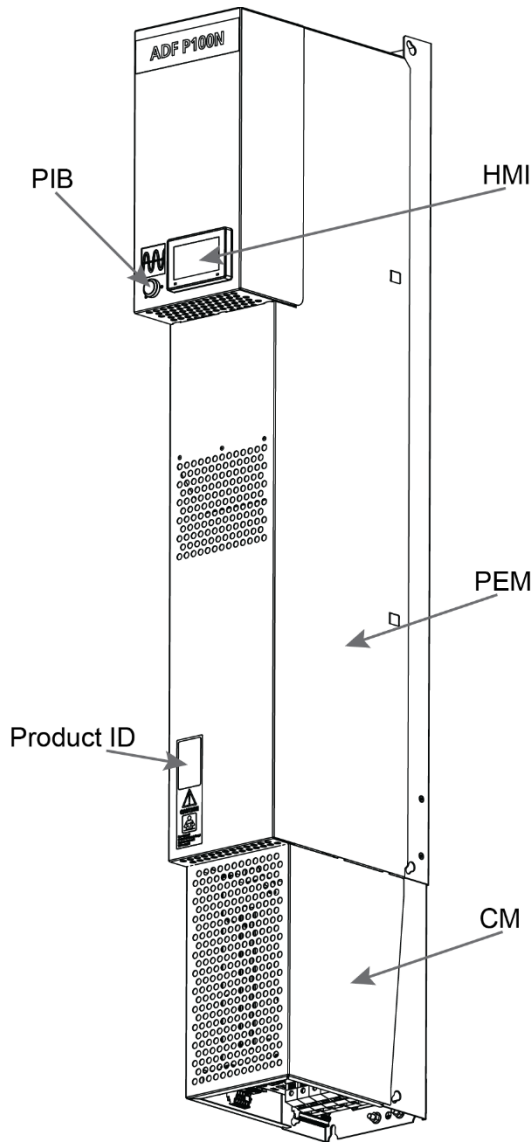


Figure 3: ADF P100N external overview with HMI

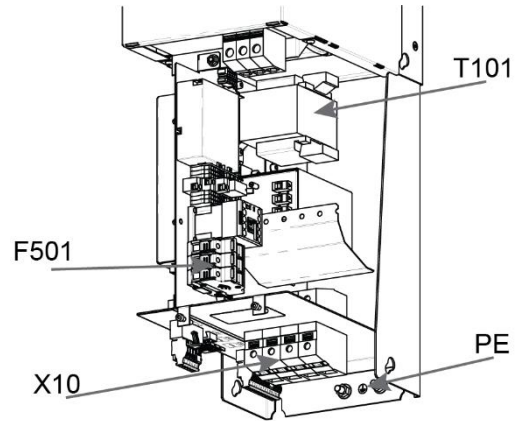


Figure 4: ADF P100 with open CM hood

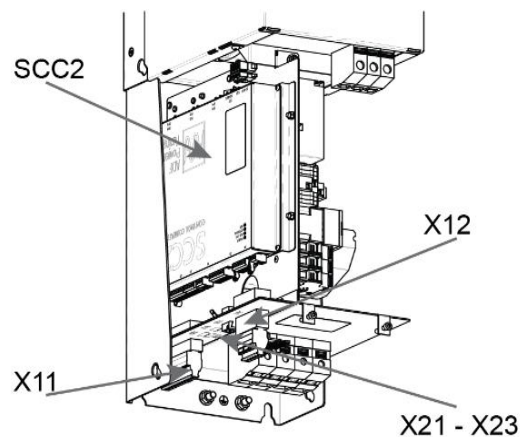


Figure 5: ADF P100 with open CM hood

### 2.2.2.1 User interface (HMI) (optional)

All settings, configuration and operation can be performed from the HMI (Human Machine Interface) panel, see Figure 3. Please refer to the ADF P100/P300 User Manual (1 199 172) on how to use the HMI.

### 2.2.2.2 Power Indication Button (PIB)

Basic operations like start and stop, can be performed on the PIB. The button also shows basic information on an indication light, internal in the button.

The ADF is powered ON by pressing this button short, and powered OFF by pressing the PIB for two seconds.

Table 4: PIB color coding

Color	Description	Button action
Fading red	System in trip and log is being written to SD-card	None
Solid red	System in trip	Acknowledge all alarms
Fading yellow	Pre-charge / all other states	None
Solid yellow	System in stopped	Start system
Fading green	System is in standby	Stop system
Solid green	System is running	Stop system
None	System is powered off	Boot system

### 2.2.2.3 Power Electronics Module (PEM)

The top part of the ADF P100, upper three quarter in Figure 3, is the Power Electronics Module that actually generates the compensation currents. The power processor contains power electronics such as IGBT modules and driver electronics, EMC-filter, DC-storage, cooling fans and line filtering components.

### 2.2.2.4 Control Module (CM)

The Control Module has three major functions; Control of power processor, auxiliary power, and customer interface. It contains most automation components.

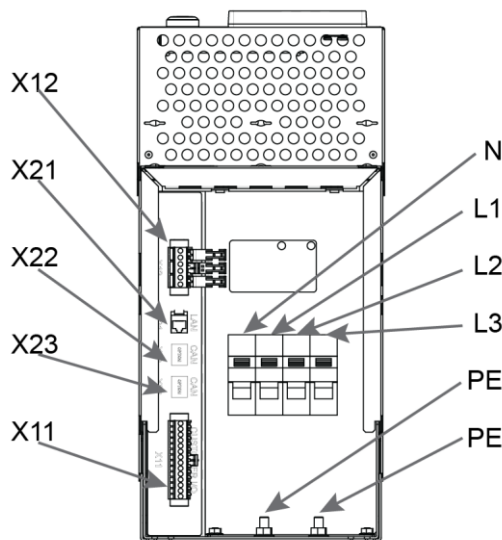


Figure 6 Customer Electrical Interface of ADF P100

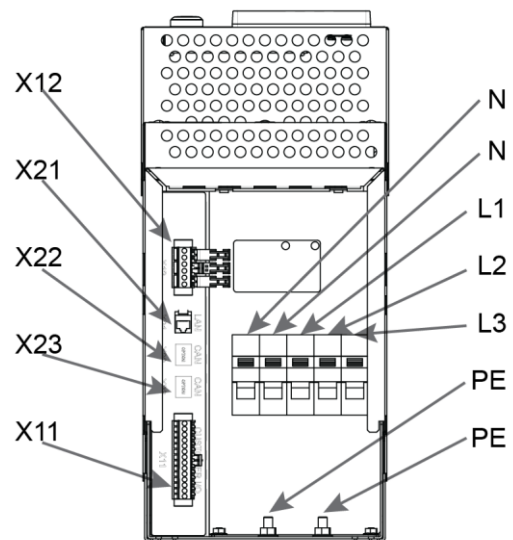


Figure 7 Customer Electrical Interface of ADF P100N

### 2.2.2.5 Control computer (SCC2)

The SCC2 control computer is a stand-alone digital processing system containing all functions for controlling the power processor modules. It also features protection circuitry for monitoring and main contactor control. Indicators on the front panel display operational modes and status as well as power as shown in Table 5.

Please note, LED indication is hard to see when system is assembled.

Table 5: SCC2 control computer front panel LED indicators

Description	Color	Description
POWER	Blue	Indicates that the control computer has power.
RUN/OK	Red/ Green/ Yellow	Active Filter operational status: <b>Green blink</b> = System is running. <b>Yellow blink</b> = System is stopped. <b>Red/yellow blink</b> = System is tripped / an alarm is active. <b>Steady yellow</b> = System is in Setup mode. <b>Fast red blink</b> = SCC2 boot-up failure.
NETWORK	Yellow	LAN network activity (if connected)
TRIP	Red	SCC2 hardware trip. If lit the control computer is malfunctioning.

### 2.2.2.6 Auxiliary voltage transformer (T101)

The auxiliary voltage transformer (T101) transforms mains voltage to 230 V<sub>AC</sub>.

### 2.2.2.7 Auxiliary fuse block (F501)

Auxiliary fuse block (F501), located inside the unit, protects voltage measurement circuits, pre charging circuits and auxiliary power systems inside the Active Filter.

### 2.2.2.8 Power connection terminals (X10)

Used for connection of mains to the system. See section 4.3.3 for detailed connection information. The terminals are placed in the lower part of the cabinet.

### 2.2.2.9 Earth connection (PE)

Main PE connection.

### 2.2.2.10 User signal interface (X11)

The user signal interface terminals, X11, are used for interface to external devices via alarm outputs and digital inputs. See section 4.3.5 for more information on how to connect digital inputs and outputs.

### 2.2.2.11 Current transformer interface (X12)

Current transformer interface terminals, X12, are used for connecting current transformer. See section 4.3.5 for more information on how to connect current transformer (CT's).

### 2.2.2.12 LAN connection (X21)

LAN connection for interfacing the ADF Dashboard Web-User-Interface. X21 also offers a Modbus TCP interface (optional).

### 2.2.2.13 CAN interface (X22 & X23; optional)

CAN-bus connections X22 and X23 for interconnecting ADF systems for parallel operation in closed loop setup.

## 3 Getting started

This section is intended to help you get through to operate the Active Filter with the least work on your part. Guidance and hints are provided. First it is important that you read and observe the safety notes in the beginning of this manual to help avoid damage to equipment, installation and persons.

### 3.1 Receiving and unpacking

On receiving the unit read notes in section 4.1 “Unpacking the Active Filter”. If the system is to be transported on site, please be sure to avoid excessive strains. In particular, no components must be bent or isolating distances altered in the course of transportation or handling. No contact must be made with electronic components and contacts. Also note that all operations serving transport, installation and commissioning as well as maintenance must to be carried out by skilled technical personnel.

Active Filters contain electrostatic sensitive components which are liable to damage through improper use. Electric components must not be mechanically damaged or destroyed (potential health risks).

### 3.2 Installation

It is important to prepare the installation site prior to installing and connecting the Active Filter. In the section 4 “Installation”, important issues such as location of terminals, cable size recommendations, ADF P100 over current protection and cooling air flow requirements are discussed. To maintain operation and long equipment life it is vital to keep environmental conditions in accordance with the specifications.

Current transformer (CT) selection is important for good performance. Read about CT selection and connection in section 4.3.6 “Current transformer terminals (X12)” and if possible use separate CTs not shared with other equipment e.g. power quality meters.

Notice that an operation without current transformer is also possible. “Voltage Control” is an optional operation mode.

Good earth connection is also important to achieve best results and electrical safety as described in the section 4.3.2 “Protective earth (PE) connection”.

It is important that any materials or method for connection used is within limits with respects to local safety regulations. Also that appropriate fuses are fitted in the mains connection.

### 3.3 Configuration and Commissioning

The Active Filter has extensive functionality built-in for several modes of operation.

The ADF P100/P300 User Manual (1 199 172) details how to configure the software parameters for the ADF P100.



## 4 Installation

### 4.1 Unpacking the Active Filter

Each Active Filter is delivered in packaging suitable for transportation. Upon reception of the Active Filter, visually inspect that the packaging is in good condition. Verify that all items are present in the package:

- This manual (1 199 273)
- The ADF P100/P300 User Manual (1 199 172)



**ATTENTION:** Before unpacking and installation the Active Filter please read through the following pages THOROUGHLY to make sure that it is handled in the right way.

The unit is heavy and weighs up to 147 kilograms / 324 lbs.

Do not attempt to move the unit before reading the lifting instruction and act accordingly.

Attempt to move the equipment without proper equipment and not according to instructions may result in damage of the equipment and injury.

#### 4.1.1 Before unpacking and Installation/Commissioning

Before moving the Active Filter without its protective packaging please pay extra attention to the section in this document that handles lifting. During transport and storage and before commissioning, keep the system protect from dust and water ingress.



**ATTENTION:** Make sure to protect the Active Filter at all times, especially during installation since the product contains very sensitive power electronics.

#### 4.1.2 Lifting the Active Filter in its box

The ADF P100 can be handled by forklifts and cranes as long as it is packaged in its protective packaging.

### 4.1.3 Lifting the Active Filter

The ADF P100 must be lifted and moved according to the instructions in this section.

Start by removing part of freight box in such a way that the ADF P100 is accessible from all sides and top when lying on its back. Only the part of the freight box under the ADF P100 back is then left. The ADF P100 is screwed to the pallet with one screw on the top and one at the bottom.

The Active Filter may only be lifted in the lifting ears on top and bottom of the Active Filter. Also the length of the straps must exceed 220 mm / 9" and be of the same length according to Figure 8. Make sure to protect the ADF P100 during lifting in such a way that it is not scratched or similar, do this by putting soft material in all points where the ADF P100 has contact with other objects.

The filter may also be manually lifted using special metal rods. Insert the metal rods in the lifting holes and manually lift the filter. The metal rods are not included. Generally round metal rod(s) can also be used.

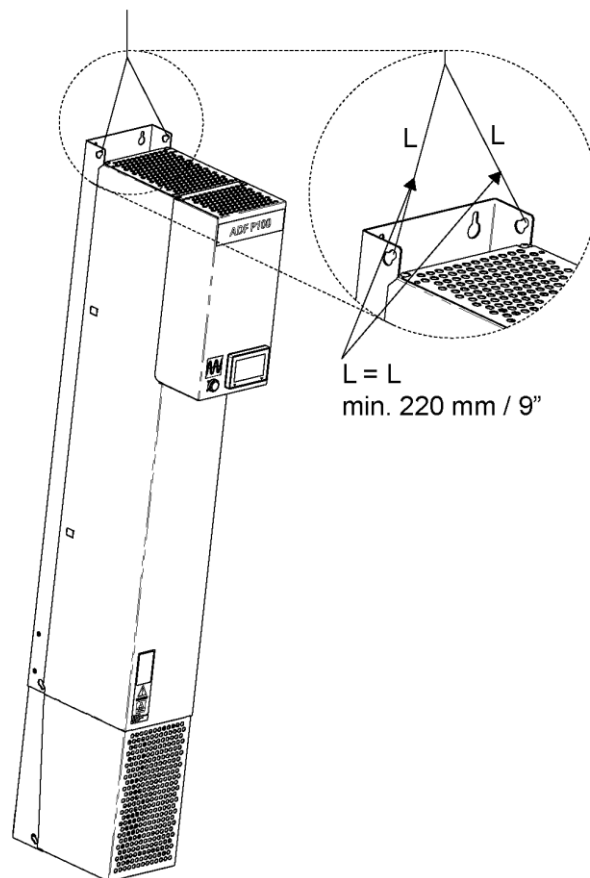


Figure 8: Correct lifting of the Active Filter

If moving the Active Filter with for example a fork lift, it may only be moved lying down on its back, not on its sides nor standing.

### 4.1.4 Wall mounting and preservation of the Active Filter

Make sure the wall and the fastening bolts can support the weight of the Active Filter. Start with fastening the screws (use M10 with flat head) in the wall as suggested by the footprint in Figure 9. Leave space between the head of the screw and the wall for the back side of the Active Filter to be fitted.

Lift the Active Filter into place over the keyholes, push it flat to the wall and lower it in place. Tighten the screws.

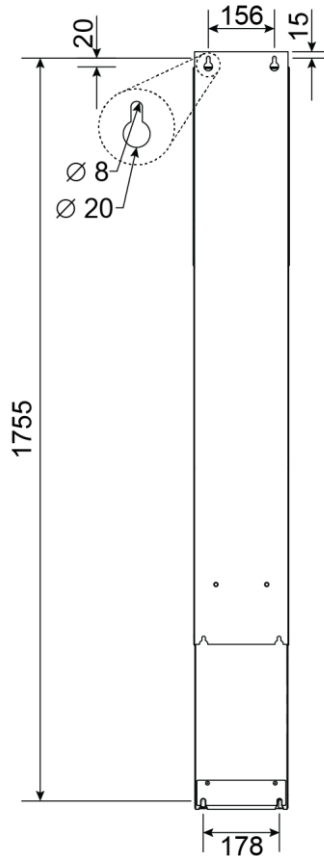


Figure 9: Footprint for wall mounting the Active Filter (in mm)

After the Active Filter has been mounted on the wall, protect the system and keep out dust and other harmful particles from the system.

### 4.1.5 Storage conditions

During storage of the unit, the unit should be kept within the following conditions. The conditions are acceptable only when the unit is kept in its shipping packaging.

Table 6: Maximum storage conditions

Maximum storage conditions (in protective shipment package)	
Temperature	-25 °C to 70 °C (-13 °F to 158 °F)
Relative humidity	Less than 95 %, non-condensing
Environmental conditions	Chemical class 3C3 Mechanical class 3S3

### 4.1.6 Transport conditions

During transport of the unit, the unit should be kept within the following conditions. The conditions are acceptable only when the unit is kept in its shipping packaging.

Table 7: Maximum transport conditions

Maximum transport conditions (in protective shipment package)	
Temperature	-25 °C to 70 °C (-13 °F to 158 °F)
Relative humidity	Less than 95 %, non-condensing
Environmental conditions	Chemical class 3C3 Mechanical class 3S3

## 4.2 Environmental conditions

### 4.2.1 Operating conditions

The unit is suitable for indoor operation only. If the unit is operated within the below limits, full power may be utilized. During more demanding conditions, the unit will be derated when approaching full power.

The unit must be placed in a well-ventilated area. For cooling air flow requirements, see section 4.2.3.

Table 8: Maximum operating environmental conditions

Maximum operating environmental conditions	
Temperature	0 °C to 50 °C, derating applies above 40 °C 32 °F to 122 °F, derating applies above 104 °F
Relative humidity	Less than 95 %, non-condensing
Altitude	1000 m (3300 ft) Derating may be required at higher altitude.
Environmental conditions	Chemical class 3C2 Mechanical class 3S2



**ATTENTION:** Make sure that the unit is installed in an environment without conductive or corrosive dust. If conductive or corrosive dust is present extra precautions must be taken. Contact your COMSYS representative.

### 4.2.2 Physical conditions

There should be a minimum of 100 mm / 4" clearance to the ceiling above the roof of the unit in order not to limit cooling air flow.

In front of the unit, there should be a minimum clearance of 400 mm / 16" to allow removal of cover. However make sure to enable service access, for example it must be possible to physically access the unit from the front. Also in front of the unit, there should be a minimum clearance of 100 mm / 4" to avoid restriction of air intake, assuming no external restrictions for air flow, for example if the ADF P100 is placed in a cabinet.

If the unit is placed inside a cabinet with a door in front of it, then the door is not considered a restriction. However consider that cooling air must not be restricted see section 4.2.3.

There is no minimal clearance to floor, however make sure that mains and signal cables have space for bending and connecting. There is no minimal clearance sideways however consider that the unit can become hot under operation.

In general local regulations may impose stricter demands.

### 4.2.3 Cooling air flow requirements

The cooling air flow requirements are dependent on operating conditions and load cycles. The following table states the maximum demanded air flow from each ADP P100:

Table 9: Minimum air flow requirements

Model	Maximum air flow	Maximum losses
ADF P100-70/480	600 m <sup>3</sup> /h	1500 W
ADF P100-100/480		2235 W
ADF P100-130/480		2970 W
ADF P100-90/690		2969 W
ADF P100N-100/415		2235 W

It is crucial that the Active Filter can utilize the needed air flow during maximum operating conditions. The cooling air may not exceed 50 °C / 122 °F under any circumstances. Derating applies above 40 °C / 104 °F.



**ATTENTION:** Make sure that the ambient temperature is below 50 °C / 122 °F under all circumstances.

Make sure that the air drawn into the unit does not contain corrosive or conductive gases of any kind. Make sure that the physical mounting guidelines are followed and that no obstruction lowers the air flow. Take care of the hot air emitted from the unit in a proper way.

Failure to observe these guidelines may result in premature aging or failure of the equipment.

The Active Filter contains internal fans that will ensure that the air flow reaches the needed capacity during maximum operating conditions. The emitted hot air must be taken care of by the room housing the unit. Hot air is emitted from the top of the unit, and to a smaller extent, from the front in the ADF P100N according to the figure below.

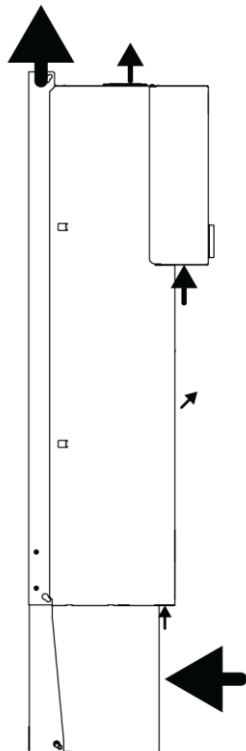


Figure 10: Air flow in ADF P100N

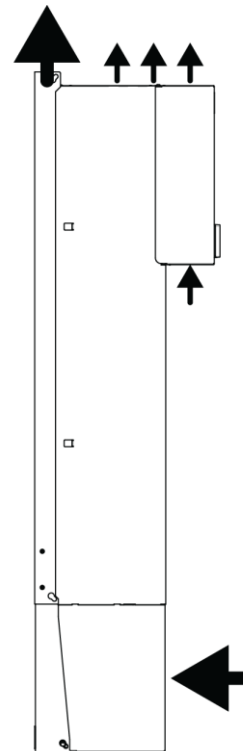


Figure 11: Air flow in ADF P100

### 4.3 Connection of the Active Filter

The Active Filter has three main connector terminals, X10 for the power interface and X12 for CT and X11 for external user functionality signals as seen in Figure 6 and Figure 7. They are located at the bottom of the unit.

### 4.3.1 Overview connection terminals of the ADF P100

In Figure 6 the connection area and the terminal names for the ADF P100 products can be seen.

### 4.3.2 Protective earth (PE) connection

Connect the protective earth to the PE screw stud (see Figure 6; lower back of the cabinet). Connecting points are two M8 screws. A cable area of at least 16 mm<sup>2</sup> is recommended. Tighten the connection with a torque of 20 Nm.



**ATTENTION:** The protective earth connection must be connected to PE in the installation and NOT to the N-conductor.

### 4.3.3 Power connection terminals (X10)

The mains power connection is made at terminals X10 see Figure 6 for ADF P100 and see Figure 7 for ADF P100N, found in the bottom of the unit. X10 accepts a wide range of different cable types (copper or aluminum, solid or stranded with or without ferrule and ferrule with or without plastic sleeve) up to 95 mm<sup>2</sup>, for further detailed information please contact Comsys.

ADF P100 systems have one terminal each for L1, L2, L3 and Neutral. ADF P100N systems have one terminal each for L1, L2 and L3 as well as two terminals for the Neutral connection. ADF P100N systems needs to have all terminals connected!

Mount the cabling using the appropriate accessories. Use a torque of 15 – 20 Nm.



**ATTENTION:** After running the Active Filter, wait at least 60 minutes after opening the main feeding circuit to guarantee that there is no residual voltage on the DC capacitors. Failure to observe these guidelines may result in injury or loss of life.

**ATTENTION:** Note that the Active Filter is fed from an external point. Only in this point, like a MCB or fuse disconnecter, it is possible to open the main feeding to the Active Filter.

**ATTENTION:** The current on the Neutral wire in the ADF P100N can be up to 3 times as high as the Phases. This needs to be taken into account for the MCB or fuse disconnecter



**ATTENTION:** The active filter must be connected via either fuses or a circuit breaker that can be operated by the user and are suitable for the short circuit power in the feeding network. Since there is no main fuse or breaker in the ADF P100, the only way to make the system fully de-energized is to open the fuse or breaker feeding X10.

#### 4.3.3.1 Selection of power cable size

In order to guarantee that the cables are not overheated some derating has to be introduced. This is due to the skin effect caused by the harmonics. The cable sizes in Table 10 are given as recommendations without warranty of suitability.

**NOTE** Please note, two parallel neutral cable need to be used for the ADF P100N

Table 10: Recommended cable sizes

Intended unit max current	Derating factor
70 A <sub>RMS</sub>	x 1.5
100 A <sub>RMS</sub>	
130 A <sub>RMS</sub>	
300 A <sub>RMS</sub> (Neutral connection)	x 1.3



**ATTENTION:** The dimensions given in Table 10 only take the skin effect into consideration due to the load current being mostly harmonics. Local regulations must be observed and followed and other installation conditions which may affect the sizing of the cables, number of parallel conductors, distance and layout between conductors, and such parameters. Consult your cable manufacturer for the appropriate cable. The above guidelines are only recommendations with no warranty of suitability.

#### 4.3.3.2 Main fuse selection

The switchgear feeding the unit must provide a breaker or fusing capable of interrupting the short circuit power. The unit must be protected for over current at least according to the nominal current rating of the model installed. In case of the ADF P100N the protection for the neutral cable needs to be 3 times as high as the phases.

Local regulations may impose further demands on external fusing and/or external circuit breakers.



**ATTENTION:** Note that the fuses may have to be derated due to the load characteristics if for example the unit is used for harmonics only. Consult with the fuse supplier.

#### NOTE

It may be considered to use fast fuses (semiconductor type) for protecting the P100(N). With semiconductor fuses, the damage in a short circuit condition is reduced, meaning lower repair cost. Note that in this case cable protection must also be considered.

#### 4.3.4 Auxiliary Transformer Setup

The ADF P100 includes an auxiliary transformer which supplies internal circuits with 230 V<sub>AC</sub> voltage. The auxiliary transformer is marked T101 in the previous figures. Four different transformer are used for different voltages.

Table 11: Voltage range 208 – 415 V

Nominal Primary	+15	0	-15	230	400
215 V			N	P	
230 V		N		P	
245 V	N			P	
385 V			N		P
400 V		N			P
415 V	N				P

Table 12: Voltage range 380 – 480 V

Nominal Primary	+20	0	-20	400	460
380 V			N	P	
400 V		N		P	
420 V	N			P	
440 V			N		P
460 V		N			P
480 V	N				P

Table 13: Voltage range 480 – 600 V

Nominal Primary	+25	0	-25	500	575
475 V			N	P	
500 V		N		P	
525 V	N			P	
550 V			N		P
575 V		N			P
600 V	N				P

Table 14: Voltage range 690 V

Nominal Primary	N/A	0	N/A	N/A	690
690 V		N			P

The transformer primary is not connected when the unit is delivered from factory. Thus, it is necessary to select the proper primary winding in order to supply 230 V<sub>AC</sub> to the internal circuits. Please select a tap that is closest to the operating voltage of your system.

The connection is made by connecting the loose wire to the appropriate terminal.



**ATTENTION:** Do not use a primary voltage that differs more than 10 per cent from the nominal voltage. In case such a primary voltage must be used, order a custom transformer from Comsys AB. Please refer to the table above.

**ATTENTION:** Selecting a too low voltage will result in overheating of some components. In worst case selecting a too low voltage will cause fire.

### 4.3.5 User signal interface (X11)

The external interface terminal block X11 (see section 2.2.2.4) are connections for digital inputs, digital outputs and alarm output.

Table 15: External interface terminals X11

Terminal No	Description
X11:1	Digital IN1 NO, 24 VDC
X11:2	Digital IN2 NO, 24 VDC
X11:3	Digital IN3 NO, 24 VDC
X11:4	Digital IN COM GND
X11:5	N/A
X11:6	Digital OUT1 NO
X11:7	Digital OUT1 COM
X11:8	N/A
X11:9	N/A
X11:10	N/A
X11:11	N/A
X11:12	Alarm relay NO
X11:13	Alarm relay COM
X11:14	PE

The digital outputs Alarm relay and Digital output OUT1 are of the following specification:

- Switches 5 A at 250 V<sub>AC</sub> / 30 V<sub>DC</sub>, resistive load



### 4.3.6 Current transformer terminals (X12)

Current transformers are connected to terminal block X12:1 – X12:6 in the bottom of the unit.

CT's are not needed in all installations. The optional Voltage Control operates without the need of CT's. In Current Control (standard), CT's are required.

The terminal block X12 provides a short circuit possibility for the incoming cable. The short circuit needs to be removed before operating.

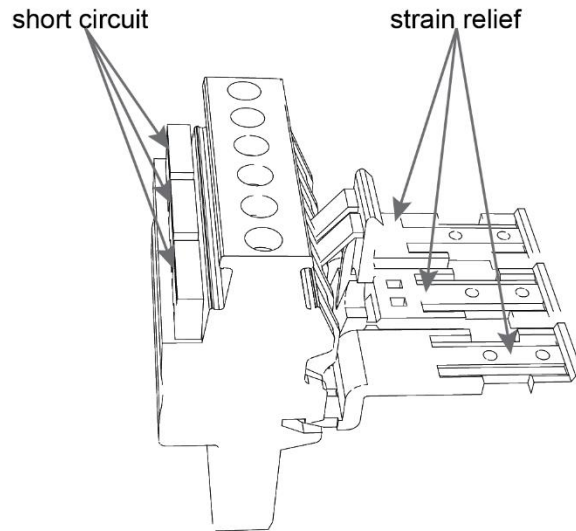


Figure 12: X12 terminals; with closed short circuit

Table 16: External interface terminals X12

Terminal No	Description
X12:1	S1, Current transformer L1
X12:2	S2, Current transformer L1
X12:3	S1, Current transformer L2
X12:4	S2, Current transformer L2
X12:5	S1, Current transformer L3
X12:6	S2, Current transformer L3

#### 4.3.6.1 Selection of current transformers

The current transformers should fulfill the following specification:

Table 17: Current transformer (CT) specification

Current transformer specification	
Class	1.0 or better
Primary ratio	Exceeding the maximum load current including harmonics, reactive power, and transients
Secondary ratio	5 A
ADF total CT burden	0.193 VA
Symmetry	Three identical CTs must be used; ADF P100N does not require a CT on the neutral wire.

Note that the size of the CT is critical to the performance of the system when operating in current control. Using a very large CT in relation to the active filter size will result in poor resolution and hence poor results.



**ATTENTION:** Current Transformers with 5 A secondary must be used, since CTs with 1 A secondary will give to low measurement resolution.

#### 4.3.6.2 Recommended current transformer cable size

The recommended cable size used for connection of the current transformers is dependent of the output power of the current transformers and total length of the cables. A calculation of burden must be performed to guarantee that the burden of the CT is not exceeded. Table 18 shows the need required burden in relation to the cable size and length for some examples

Table 18: Burden as function of cable size and length

	5 m	10 m	20 m	30 m	50 m	100 m	160 m
<b>0.5 mm<sup>2</sup></b>	4.4 VA	8.6 VA	17.0 VA	25.4 VA	42.2 VA	84.2 VA	134.6 VA
<b>0.8 mm<sup>2</sup></b>	3.0 VA	5.8 VA	11.4 VA	17.0 VA	28.2 VA	56.2 VA	89.8 VA
<b>1.0 mm<sup>2</sup></b>	2.3 VA	4.4 VA	8.6 VA	12.8 VA	21.2 VA	42.2 VA	67.4 VA
<b>1.5 mm<sup>2</sup></b>	1.6 VA	3.0 VA	5.8 VA	8.6 VA	14.2 VA	28.2 VA	45.0 VA
<b>2.5 mm<sup>2</sup></b>	1.1 VA	1.9 VA	3.6 VA	5.3 VA	8.6 VA	17.0 VA	27.1 VA
<b>4.0 mm<sup>2</sup></b>	0.8 VA	1.3 VA	2.3 VA	3.4 VA	5.5 VA	10.7 VA	17.0 VA
<b>6.0 mm<sup>2</sup></b>	0.6 VA	0.9 VA	1.6 VA	2.3 VA	3.7 VA	7.2 VA	11.4 VA

Table 19 ADF CT connection data

<b>ADF CT connection data</b>	
Conductor cross section solid min.	0.14 mm <sup>2</sup> / AWG 26
Conductor cross section solid max.	6 mm <sup>2</sup> / AWG 10
Conductor cross section stranded min.	0.14 mm <sup>2</sup> / AWG 26
Conductor cross section stranded max.	6 mm <sup>2</sup> / AWG 10

#### 4.3.6.3 Location of current transformers

The location of the current transformers is critical to the function of the Active Filter. The following guidelines should be observed for proper operation:

Closed loop control is preferred. This means that the CTs monitor the load current and the Active Filter current. However, open loop control is also possible – meaning that the CTs are placed downstream to the mains connection of the Active Filter unit.

Beside the current control in, in open and closed loop, the ADF systems also support the optional voltage control.

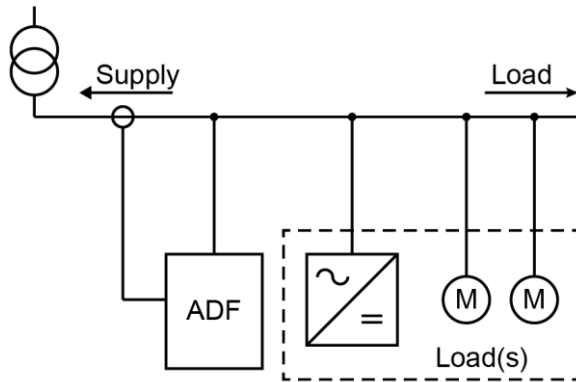


Figure 13: Current Transformer placement diagram – closed loop

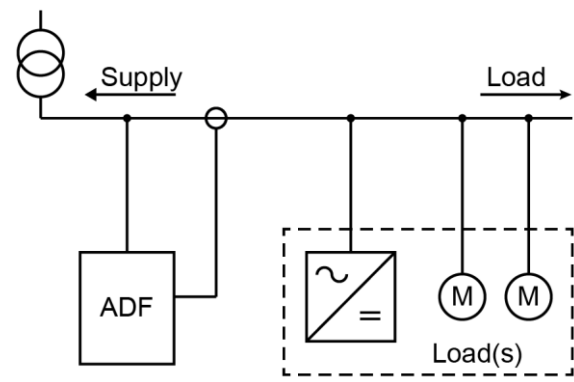


Figure 14: Current Transformer placement diagram – open loop

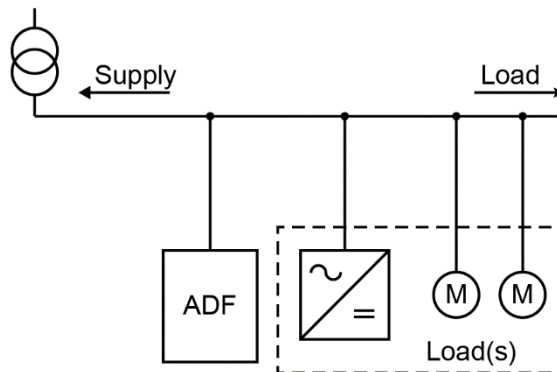


Figure 15: No current transformer in voltage control



**ATTENTION:** Never open the circuit of a connected current transformer. During all connection work, short circuit the secondary of the current transformers.

Failure to short circuit the current transformers may cause dangerous voltages, arcs and destruction of the current transformers. When connection is complete, the short circuit must be removed.

#### 4.3.6.4 Connection and wiring of current transformers

- The S1 terminal of each CT must be oriented to the supply side. The S2 of each CT must be oriented toward the load side.
- The CTs must be grouped properly phase wise with the corresponding mains connection. This means that the connected to phase 1 on X12 must monitor the current corresponding to phase L1 of the network line connection.
- The phases must be connected in proper rotation. L2 must lag L1, L3 must lag L2 and L1 must lag L3.
- Either S1 or S2 must be individually connected to PE (Protective Earth). The connection must be performed identically for each CT.
- The connection is made to terminal block X12:1 through X12:6.
- When using the Active Filter in conjunction with a passive filter, special requirements apply. See “Appendix B Compatibility with passive compensation” for further information.

The wiring should be connected according to Table 20.

Table 20: CT connection table

Phase	Current transformer	Terminal block
Phase L1 / A	S1	X12:1
	S2	X12:2
Phase L2 / B	S1	X12:3

	S2	X12:4
Phase L3 / C	S1	X12:5
	S2	X12:6

In Figure 16 and Figure 17, the correct connection of mains power and current transformers with correct grounding is illustrated. The example shows close loop operation on an ADF P100 and ADF P100N.

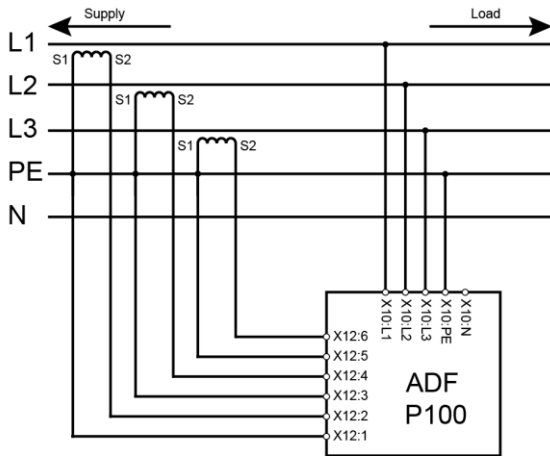


Figure 16: ADF P100 Current Transformer connection diagram – closed loop

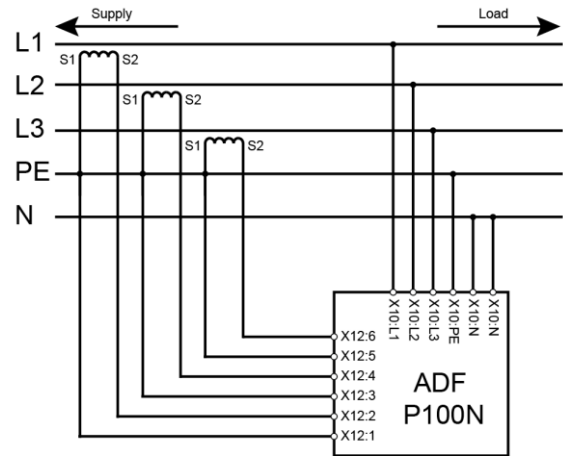


Figure 17: ADF P100N Current Transformer connection diagram – closed loop

#### 4.3.6.5 Connection of current transformers with paralleled systems

Figure 18 illustrates correct connection of two paralleled Active Filters, again in closed loop operation with correct grounding:

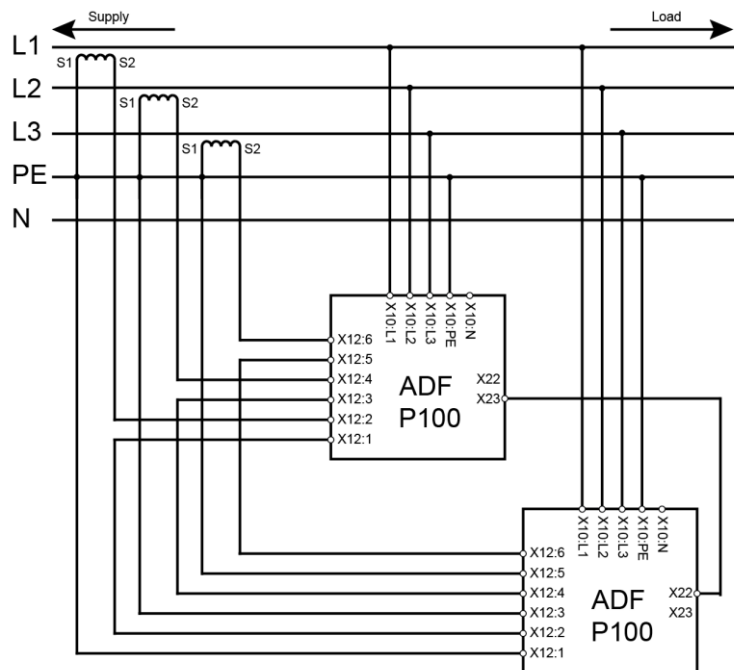


Figure 18: Current Transformer connection diagram – paralleled units

#### 4.3.6.6 Use of summation transformers

Summation transformers can be used in certain configurations. Some examples of usable scenarios:

- When compensating loads, in closed loop operation, fed by two or more transformers which are paralleled. The secondary sides must then be added to the current input of the ADF P100 using a summation transformer.
- When compensating loads, in open loop configuration, where the main CTs must be placed on two or more outgoing groups.

In all cases, when using summation CT's, the ratio must be selected so that full signal corresponds to 5 A on the secondary of the summation transformer going into the X12 terminal block.

#### 4.3.7 Local area network (X21)

The RJ45 LAN socket allows connection to the SCC2 control computer and is used for configuration and monitoring of the ADF via a standard Ethernet network or directly from a PC. Optional this RJ45 also supports Modbus. Please see the User Manual for more information on how to connect to the ADF.

#### 4.3.8 CAN bus (X22 & X23; optional)

The RJ45 CAN-bus sockets are used for inter-ADF communication for example when several ADFs are operated in parallel in Multi-Master operation. ADFs are connected as a daisy-chain with termination plugs in each end of the chain like shown in figure below. X22 and X23 are freely interchangeable.

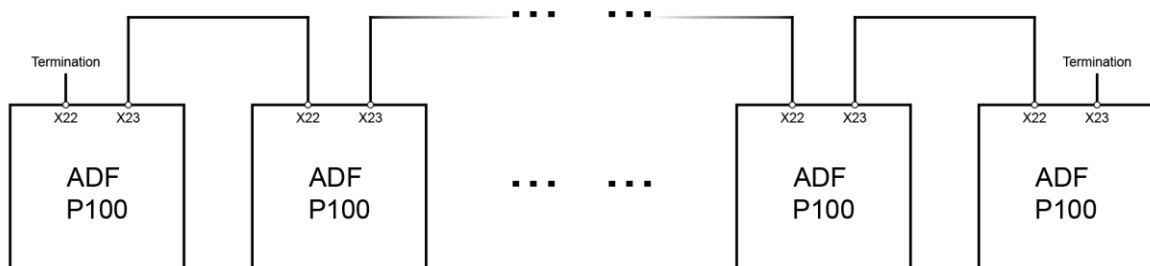


Figure 19: Example setup for Multi-Master operation

A “FTP category 5” or better Network cable can be used to connect ADF's to each other. The maximum length of the entire cable is 100 m / 328 ft.



**ATTENTION:** The electrical interface of the RJ45 CAN bus connectors is different from that of the LAN. Be sure to only connect equipment approved by Comsys on this bus or equipment damage may result.

## 5 Maintenance

This chapter is divided into two parts; firstly, all systems maintenance which is identical to all variants of the ADF P100 is covered.

The ADF P100 is fully serviceable from the front, bottom and top after removing all covers. All internal parts can be changed without dismantling the entire unit if for example mounted on a wall.

Every 6 months, a routine inspection is performed. In most cases, no components are exchanged during biannual inspection.

<p><b>NOTE</b> Warranty is void if maintenance is not performed according to schedule.</p>
--



**ATTENTION:** All maintenance must be performed by trained and qualified personnel.

Make sure no voltage is present in main circuit, auxiliary power system, AC voltage measurement circuits and power capacitors.

Follow the guidelines for preparing the ADF P100 for maintenance before attempting to perform any work in this section.

ADF P100 consists of electronics sensitive to electrostatic voltage.

When tightening electrical or mechanical connections be sure to apply the correct torque.

Before attempting any maintenance, the ADF P100 must be shut down by disconnecting the mains in the customer switchgear or similar, followed by taking appropriate safety measures.

### 5.1 Biannual inspection

The following items are included in the maintenance procedure:

- Visual inspection
- Cleaning
- Cooling system
- Cover inspection
- Electrical connections

#### 5.1.1 Removal of covers

In order to be able to perform inspections the covers must be removed.

Start by remove the cover of the Control Module (CM), see section 2.2.2. Do this by loosen the two screw partly. Pull the cover downwards and remove it.

Remove the small white cover mounted on the top by losing the screws and pull cover down. Make sure to disconnect the HMI and PIB cable.

Remove the main cover by loosen the mounting screws on the top and remove the screws on the bottom, then lift it off.

#### 5.1.2 Visual inspection

The cover must be removed. A visual inspection must be performed of all the system. Check for any of the following items:

- Dust
- Condensation
- Abnormal smell, discoloration, soot or swelling of components
- Cracks in plastic covers

- Inspect DC capacitors for signs of overheating; be aware of swollen capacitors and signs of overheating. Such capacitors must be replaced.
- Inspect line filter AC capacitors, check for signs of damage.
- Inspect internal contactors; check for sign of damage such as soot or other discolor.
- Inspect internal cables for signs of insulation wear due to poor routing.

Pay particular attention to presence of conductive dust.

### 5.1.3 Cleaning

All dust must be removed. The best way of doing this is to use pressurized air (from a compressor system).



**ATTENTION:** The equipment is sensitive to ESD. Avoid cleaning the system with any method which may cause build-up of ESD; such as vacuum cleaning, using cloths, etc.

Dust build-up may cause unreliability and component failure in the worst case.

### 5.1.4 Electrical connection

Visually inspect all electrical connections. Check for signs of heated cable terminations and damaged insulation.

Check the torque on mains connections and PE.

### 5.1.5 Change and inspection of internal fuse

Inspect the auxiliary fuses (F101) located in the Computer Module (CM).

### 5.1.6 Cooling system

The ADF P100 has one main fan and the ADF P100N additionally an auxiliary DC fan. The main fan in the bottom with air outlet on the top of the unit located at one quarter from the bottom and the auxiliary fan on the top of the ADF P100N cabinet.

After restarting the unit; check that no noise indicating fan wear is audible. Also check that the air flow is strong by putting the hand over the unit.

## Appendix A Technical Specifications

The product is named according to current capacity and maximal nominal voltage. The naming follows the form

ADF P100-130/480

Where 'P100' indicates the model family, '130' is the current capacity, and '480' the maximum allowed nominal voltage. Note that the voltage always indicates a usable interval; please see the specification tables below.

Currently, the following models exist:

Table 21: Available ADF P100 models

Product Line	Models	Art no
ADF P100, 3 wire	ADF P100-70/480	400 096
	ADF P100-100/480	400 097
	ADF P100-130/480	400 098
	ADF P100-90/690	400 082
ADF P100, 4 wire	ADF P100N-100/415	400 095

### A.1 Technical Data – ADP P100

Table 22: Technical specifications ADP P100

Characteristics				
Model	ADF P100-70/480	ADF P100-100/480	ADF P100-130/480	ADF P100-90/690
Rated power *	49 / 59 kVA	70 / 84 kVA	91 / 109 kVA	94 /108 kVA
Compensation current capacity at 50/60 Hz	70 A <sub>RMS</sub>	100 A <sub>RMS</sub>	130 A <sub>RMS</sub>	90 A <sub>RMS</sub>
System voltage **	480 V (208 – 480 V)			690 V (480 – 690 V)
Nominal frequency **	50/60 Hz ± 2 %			
Number of phases	3 phase 3 wire			
Connection type	3 phase without neutral (TN, TT, IT)			
Harmonic current compensated	individual compensation up to 49 <sup>th</sup> order			
Rate of harmonic reduction	better than 98 %			
Current compensation of cos φ	up to 1.0			
Expandability	ADF P100 units can be used in parallel			
Response time	< 1 ms			
Power dissipation	< 1500 W	< 2235 W	< 2970 W	< 2969 W
Maximum air flow requirement	600 m <sup>3</sup> /h			
Noise level	< 70 dB(A)			
Environment	0 to 95 % RH non-condensing, max altitude 1000 m			
Operating temperature	0 to 50 °C, up to 40 °C without derating			
Dimensions	230 x 1790 x 470 mm (W x H x D)			
Weight	145 kg			155 kg
Enclosure color	RAL 7035 (gray) RAL 5017 (blue)			
Protection class	IP20 according to IEC 529			
Environmental conditions	chemical 3C2, mechanical 3S2			
Electromagnetic compatibility	EN 61000-6-2, EN 61000-6-4			
Certificates	CE			
Art no	400 096	400 097	400 098	400 082

\* Compensation power at 400 V / 480 V (600 V / 690 V) nominal voltage

\*\* Please state your system voltage and line frequency when ordering



## A.2 Technical Data – ADP P100N

Table 23: Technical specifications ADP P100N

Characteristics	
Model	ADF P100N-100/415
Rated power *	70 / 84 kVA
Compensation current capacity at 50/60 Hz	100 A <sub>RMS</sub> / 300 A $\Psi$
System voltage **	480 V (208 – 480 V)
Nominal frequency **	50/60 Hz $\pm$ 2 %
Number of phases	3 phase 4 wire
Connection type	3 phase with neutral (TN, TT, IT)
Harmonic current compensated	individual compensation up to 49 <sup>th</sup> order; 19 <sup>th</sup> order in neutral
Rate of harmonic reduction	better than 98 %
Current compensation of cos $\phi$	up to 1.0
Expandability	ADF P100N units can be used in parallel
Response time	< 1 ms
Power dissipation	< 2235 W
Maximum air flow requirement	600 m <sup>3</sup> /h
Noise level	< 70 dB(A)
Environment	0 to 95 % RH non-condensing, max altitude 1000 m
Operating temperature	0 to 50 °C, up to 40 °C without derating
Dimensions	230 x 1790 x 470 mm (W x H x D)
Weight	147 kg
Enclosure color	RAL 7035 (gray) RAL 5017 (blue)
Protection class	IP20 according to IEC 529
Environmental conditions	chemical 3C2, mechanical 3S2
Electromagnetic compatibility	EN 61000-6-2, EN 61000-6-4
Certificates	CE
Art no	400 095

\* Compensation power at 400 V / 480 V nominal voltage

\*\* Please state your system voltage and line frequency when ordering

$\Psi$  Derating applies above 415 V

### A.3 Dimensions – ADP P100

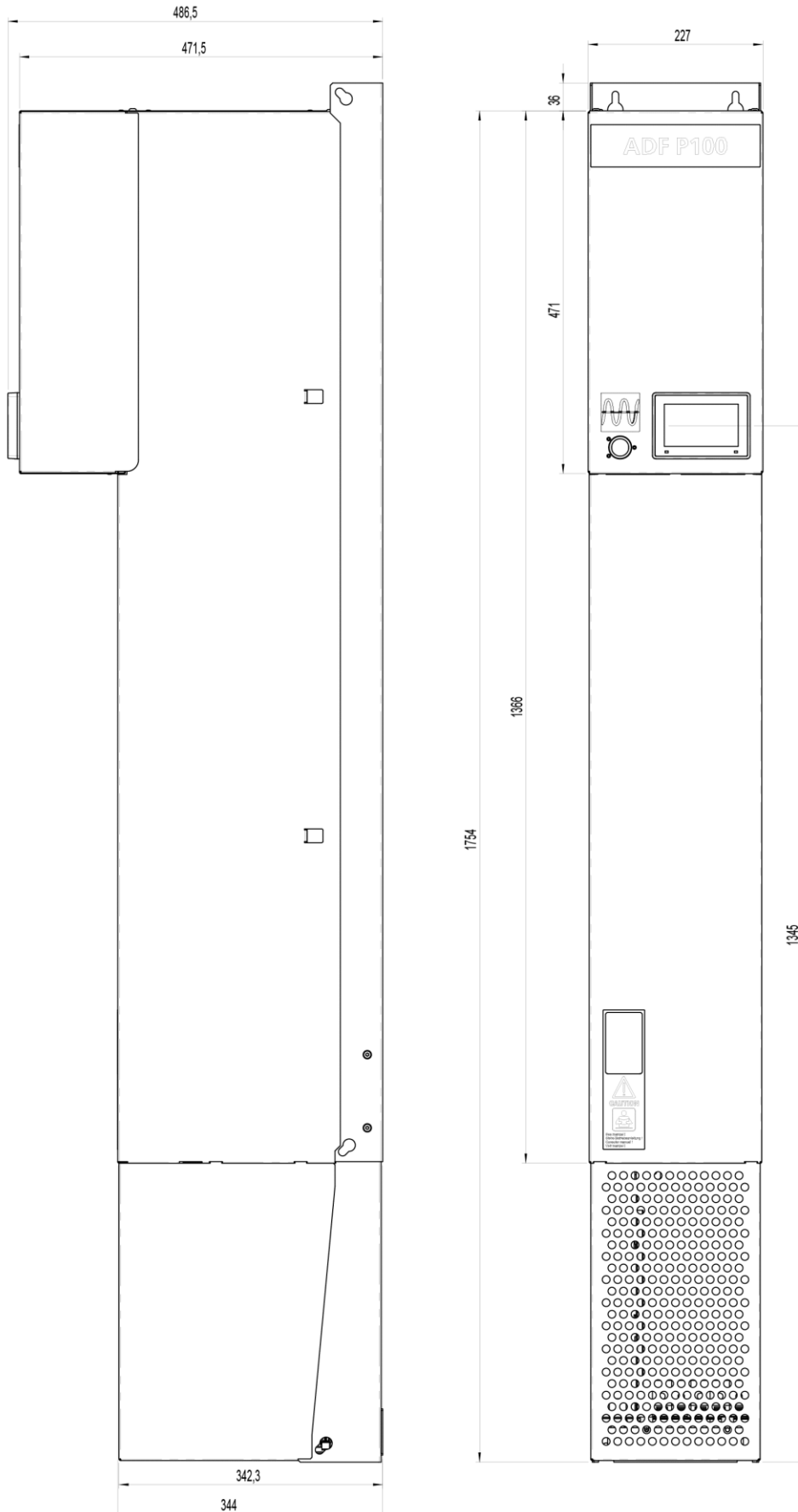


Figure 20: Dimensions ADF P100 (in mm)

### A.3 Dimensioning – ADP P100N

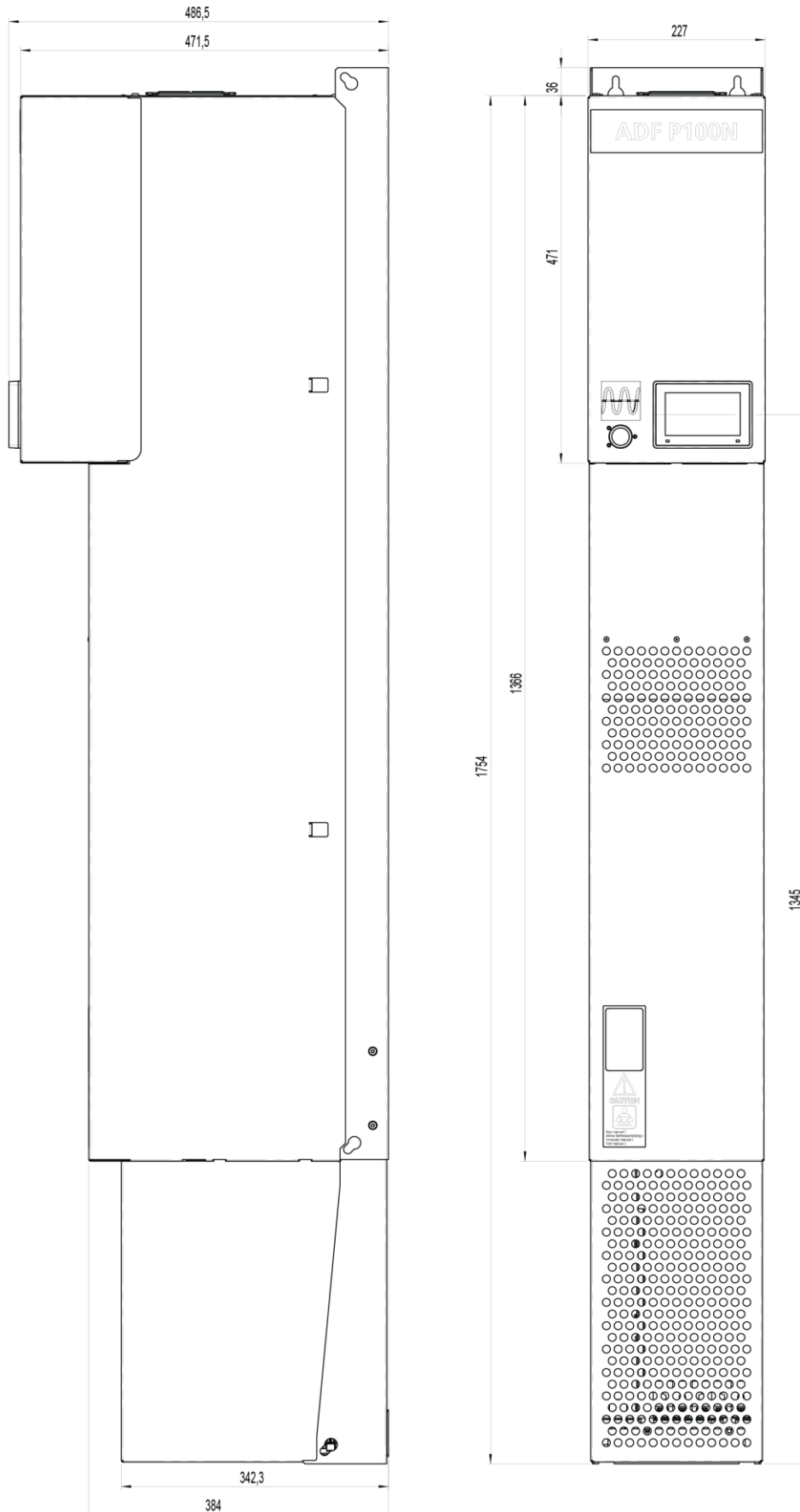


Figure 21: Dimensions ADP P100N (in mm)

## Appendix B Compatibility with passive compensation

Capacitor banks are often used in various configurations to lower the reactive power in an installation. It is a recognized problem that capacitors have impedance that falls with rising frequency and hence act as a sink for harmonics.

It is **not recommended** to use Active Filter units in conjunction with direct connected passive compensation without series reactors. Detuned capacitor banks are easier to integrate with Active Filters.

In all cases, the capacitor bank should be connected prior to the current measurement used for the Active Filter, as illustrated in Figure 22 below. When using the Active Filter in conjunction with detuned capacitor banks, it is strongly recommended to configure the Active Filter for closed loop current measurement.

The passive compensation **must** be placed upstream to the Active Filter.

Note that the Active Filter unit's current transformers (CTs) are placed prior to the load, but after the passive compensation, viewing from the supply side.

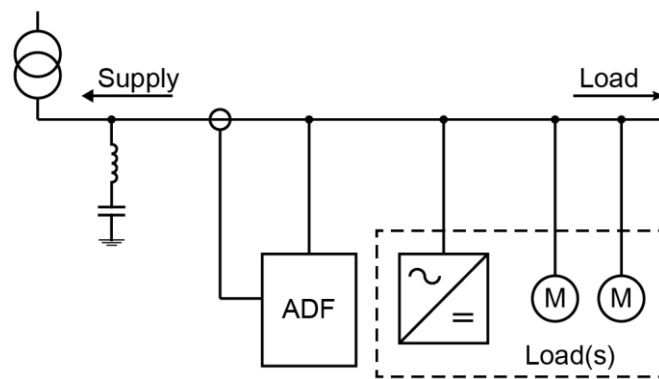


Figure 22: Connection of an Active Filter unit, passive compensation, and location of CTs.



**ATTENTION:** Failure to observe the orientation guidelines above will significantly shorten the lifetime of the passive compensation, lower the efficiency of both the Active Filter unit and the passive compensation, and may cause unpredictable results.

## Appendix C Harmonics derating

The current rating of Active Filter units is specified at the system frequency (50 or 60 Hz). This is sufficient in all normal applications since higher harmonics are lower in amplitude in most cases. For special application, requiring very high harmonic current in high harmonic orders, special care must be taken. A rating of 100  $A_{RMS}$  does not imply that the unit can output 100  $A_{RMS}$  @ 1250 Hz (25<sup>th</sup> harmonic in a 50 Hz system).

The following guidelines are useful for determining the maximum allowable higher harmonic current during normal operation of COMSYS Active Filters.

### C.1 Single harmonic maximum current

The following guidelines are established for maximum continuous current only when the unit is running at maximum rated ambient temperature. During dynamic operation with lower ambient temperature than the maximally allowed, burst currents may be significantly higher. In the same fashion, in continuous operation at temperatures higher than the maximum allowed, the unit automatically derates the output in order to not shorten component lifetime.

The following table can be used to determine the maximum individual current, as percentage of the rated maximum compensation current:

Table 24: Maximum current output on single harmonics

h	Output (%)	h	Output (%)	h	Output (%)
1	100 %	19	60 %	37	40 %
3	100 %	21	55 %	39	35 %
5	100 %	23	55 %	41	35 %
7	100 %	25	50 %	43	35 %
9	90 %	27	45 %	45	30 %
11	80 %	29	45 %	47	30 %
13	75 %	31	40 %	49	30 %
15	70 %	33	40 %		
17	65 %	35	40 %		

In the given table, h is the harmonic order. For a unit rated at 130  $A_{RMS}$ , the maximum current of the 23<sup>rd</sup> harmonic is consequently 71.5  $A_{RMS}$ .

## C.2 Determining the thermal limit

Given that each harmonic current is within the limits outlined above, the total limit of the system as a whole can be determined as follows. First, calculate the individual contribution of each harmonic:

$$I_{h,contrib} = I_h / \text{OUT}(\%,h)$$

where  $h$  is the harmonic order and  $I_h$  is the corresponding current. Finally, add the individual harmonic contributions as a root sum:

$$I_{total} = \text{SQRT}(I_{3,contrib}^2 + I_{5,contrib}^2 + \dots + I_{49,contrib}^2 + I_{reactive,contrib}^2)$$

The answer is the amount of unit current rating needed to be able to compensate the load. Eventual reactive current can be added in the formula above as  $I_{reactive,contrib}$ .

### Example:

A load needs 85 A<sub>RMS</sub> at the 5<sup>th</sup> harmonic and 50 A<sub>RMS</sub> at 7<sup>th</sup> harmonic. The individual contributions are  $I_{5,contrib} = 85 \text{ A}_{RMS} / 100 \% = 85 \text{ A}_{RMS}$  for fifth harmonic and  $I_{7,contrib} = 50 \text{ A}_{RMS} / 100 \% = 50 \text{ A}_{RMS}$  for the seventh harmonic. The RMS sum of the two components are 98.6 A<sub>RMS</sub>. Thus, a 100 A unit will be sufficient to compensate the load. Adding an 11<sup>th</sup> harmonic of 35 A<sub>RMS</sub> adds an equivalent contribution of 43.8 A<sub>RMS</sub> yielding a total needed capacity of 107.8 A<sub>RMS</sub> which will not work in an 100 A unit in continuous operation at maximum allowed ambient temperature.

## C.3 Summary

In most cases the above guidelines are sufficient to establish the needed Active Filter size in order to fully compensate the desired harmonics. Since the exact calculations are complex the guidelines established in this document can be considered safe limits.

For detailed calculations or custom solutions, please contact your Comsys ADF supplier.

The formulas and guidelines are valid for all ADF P100 Active Filters systems up to the 49<sup>th</sup> harmonic.

## Appendix D Altitude derating

The current rating of the ADF units is specified up to a height of 1000 m / 3281 ft. In higher altitudes the current rating will be lowered depending on the height. The following rules apply when using ADF units above altitudes of 1000 m / 3281 ft:

### D.1 Air cooling derating

When using a ADF P100 on heights above 1000 m / 3281 ft, the maximum output will be derated according to the following:

$$\text{Altitude derating [\%]} = (h - 1000) / 100 \quad (h = \text{height in meter})$$

$$\text{Altitude derating [\%]} = (h - 3281) / 328 \quad (h = \text{height in feet})$$

For example, at an altitude of 1500 m, the derating will be 5 %. In this case a ADF P100-130/480 will not have the capability to compensate 130 A<sub>RMS</sub> but only 123 A<sub>RMS</sub>.



**Comsys AB**  
Fältspatvägen 4  
SE-224 78 LUND, Sweden  
Tel +46 (0)10 209 68 00  
Fax +46 (0)10 209 68 05  
E-mail: [info@comsys.se](mailto:info@comsys.se)  
website: [www.comsys.se](http://www.comsys.se)

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